**REMARKS**

Reconsideration and allowance are respectfully requested. Claims 20-39 are currently pending. Claims 20-39 were rejected in the Office Action dated November 20, 2003. Claims 20, 29 and 37 have been amended for clarity and now indicate that the surface normal vectors are stored in a two dimensional local coordinate system. No new matter has been entered.

I. <u>§103(a) Rejection of Claims 20-39</u>

Claim 20-39 were rejected under 35 U.S.C. §103(a) as being unpatentable over Nagasawa (U.S. Patent No. 6,061,065) in view of Cabral et al. (U.S. Patent No. 5,949,424). Based on the following remarks, Applicants respectfully traverse this rejection.

Applicant's invention relates to the shading of three dimensional computer graphic images. As discussed in the background of the invention, one such approach to obtaining accurate shading of graphic images is by the Phong shading method, whereby a surface normal is first interpolated or calculated across the entire triangle or basic unit that collectively makes up an image. Based on these interpolations, shading for each pixel or element within the triangle is recalculated. Unfortunately, the Phong method requires significant computational power due to its need to conduct multiple operations per pixel.

One alternative to the Phong method is through the use of bump mapping according to the Blinn shading method, whereby a surface normal for one point in the triangle is determined on the basis of a previous surface normal for another point in the triangle. In order to compute the shading applied to a specific point, it is necessary to retrieve data about the deviation of the surface normal from the bump map prior to actually applying this deviation to a new surface normal. The surface normal then has to be renormalized based on the orientation of the surface to which it is being applied, after

which the shading calculation can be performed. Although it provides realistic shading results, the Blinn method suffers from the same problems encountered by the Phong method, in particular, the need for significant computational power in order to be carried out, thus typically restricting it from real-time applications.

To overcome the obstacles presented in the prior art, the current Applicants developed a method for shading a three dimensional textured computer graphic image, such as that called for in independent Claim 20, that comprises, among other things, the following steps:

> providing a set of surface normal vectors corresponding to texture data for the image, wherein the surface normal vectors are stored in a two dimensional local coordinate system, and <u>an individual surface normal vector from the set of surface normal vectors is assigned to each pixel</u>;
>
> providing data defining at least one light source and its direction illuminating the image wherein the light source is defined in the same local coordinate system; and
>
> for each pixel in the image, <u>deriving a shading value to be applied to that pixel from the surface normal vector assigned to the pixel and the light source data</u>

(emphasis added).

In contrast to independent Claim 20, neither Nagasawa nor Cabral discloses or suggests providing a set of bump map surface normal vectors for a texture which are then <u>assigned</u> to pixels for application of the texture.

Nagasawa simply discloses a typical method of rendering three dimensional images that are modeled by dividing them into a number of unit surfaces and then assigning a surface normal to each unit that indicates the direction in which it

faces. However, as acknowledged in the Office Action, Nagasawa does not disclose the ability to subsequently derive shading values in order to realistically shade an image.

Cabral discloses a method for adding texture and shading to image surfaces by using bump mapping. However, unlike Claim 20 of the present application, Cabral does not provide a set of bump map surface normal vectors which are subsequently assigned to pixels of an image. Instead, Cabral's method of shading is similar to the prior art methods discussed above in that the surface normal vectors, in essence, have to be computed for each pixel in the image. Specifically, Cabral relies on a tangent space transformation to transform normal, tangent and binormal vectors from eye space to tangent space. Also included in this process is the transformation of the various shading vectors used in a bump mapping shading model into tangent space. See Cabral, 6:35. Furthermore, to achieve "greatest shading quality, the shading vectors are transformed on a per-pixel basis." See Cabral, 6:36-37. Cabral does attempt to reduce the amount of required computational power, but does so by utilizing a linear approximation to "transform the shading vectors to tangent space at every pixel. In this approximation, shading vectors are transformed to tangent space at each vertex and then interpolated on a per-pixel basis." See Cabral, 6:38-42.

Accordingly, Cabral is seen to not assign a surface normal vector to a pixel, but instead interpolate or calculate vectors for each pixel. In this manner, Cabral's shading method is similar to the prior art shading methods in that it requires complex mathematics and significant computational power and memory in order to be carried out, and thus is typically restricted to non-real time applications.

For the above reasons, Applicants believe that independent Claim 20, along with those claims dependent therefrom, are allowable over the references of Nagasawa and Cabral when considered either independently or in combination. For the same reasons, Applicants believe that independent

Claims 29 and 37 and those claims dependent therefrom, which recite similar limitations to those discussed above for Claim 20, are also allowable over Nagasawa and Cabral.

All objections and rejections having been addressed, it is respectfully submitted that the present application is in condition for allowance, and a Notice to that effect is earnestly solicited.

Respectfully submitted,

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